This document includes the Flexible Hulls in the EPA “Draft Characterization Report for Hull Coating Leachate” published in August 2003. The reference number is: EPA842-D-06-001

DRAFT
Characterization Report
Hull Coating Leachate

Flexible Hulls, Baseline Discharge, Copper Release Rates, Foul-Release Coatings, and Advanced Antifouling Coatings.

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3.0 FLEXIBLE HULLS

The Flexible Hulls vessel group includes ships that have their hulls covered with flexible elastomeric materials. The elastomeric material is applied over a steel or composite hull, but is sufficiently thick as to mitigate any consideration of the underlying hull material. Vessels with flexible hulls are typically coated with copper-containing antifouling coatings. This group includes 58 submarines distributed among three classes and the USS CHIEF (MCM 14), a mine countermeasure vessel (Mine, 2002). The Flexible Hulls vessel group includes 1.9% of all Armed Forces vessels that produce the hull coating leachate discharge. The total underwater hull wetted area for this vessel group is $2.2x10^6$ ft^2, which is 8.1% of the total underwater hull wetted area for all Armed forces vessels that contribute to this discharge.

The USS LOS ANGELES (SSN 688) class of attack submarines was selected as the representative vessel class for this group. The SSN 688 class has 51 submarines in service, and comprises approximately 86% of the number of vessels in the group. Most of the vessels in this class are submarines and are of similar size and displacement.

This vessel group currently uses the same copper ablative coatings as the Steel, Composite, and Other Non-Aluminum Rigid Hulls vessel group. Characterization Data of the copper ablative coatings is presented in Section 2.1. The unique operational profile of submarines and their flexible coatings tend to degrade the service life of the currently approved ablative coatings as compared to the service life targets for surface ships (i.e., a maximum of 12 years). Because submarines operate under significantly higher pressure than surface ships and the substrate to which the antifouling coating is applied is flexible, the relatively inflexible ablative coatings tend to crack and spall. The cracking and spalling of the currently approved ablative coatings on submarines limits the life of these coatings to less than 5 years. The Navy has evaluated, and continues to evaluate, more flexible antifouling coatings for use on flexible hulls.

3.1 BASELINE DISCHARGE

As discussed in Section 2.1, the baseline coating for the Flexible Hulls vessel group is defined as a 50/50 use of Ameron ABC #3 and International BRA640. The baseline discharge for this vessels group is the result of constituents leaching from the baseline copper ablative antifouling coating.

3.1.1 Characterization Data

Hull coating leachate discharge from these coatings is comparable to the discharge discussed in the baseline analysis. Studies conducted by the Navy and information supplied by coating manufacturers were used to characterize these coatings and the resulting discharges.

3.1.1.1 Physical Parameters

The SSN 688 class was selected to represent this group of vessels because it contains the largest number of vessels in this class. This class consists of 51 vessels that are 360 feet long with an underwater hull wetted area of 37,700 ft^2 (Navy, 1992). The hull material of these vessels is

steel covered with flexible elastomeric materials. SSN 688 class vessels are in U.S. ports for an average of 183 days per year and in transit between 0 nm and 12 nm of U.S. shoreline approximately two days per year (EPA and Navy, 1999). Additional physical parameters are not necessary for the hull coating leachate discharge, because discharge modeling is not conducted to support the environmental effects analyses.

3.1.1.2 Constituent Data, Classical Data, and Other Descriptors

Chemical data, field information, and descriptive information for the baseline copper ablative coating are presented in Section 2.1.1.2.

3.1.1.3 Discharge Generation Rates for Mass Loading

To estimate generation rates, all 51 vessels in the SSN 688 class were considered. A complete list of Flexible Hulls vessels is contained in the *Vessel Grouping and Representative Vessel Selection for Hull Coating Leachate Discharge* for (EPA and Navy, 2003c). The static copper release rate for the baseline copper ablative coatings were used for in port estimates, and dynamic release rates were used for underway estimates. Tables 3-1 and 3-2 present the estimated generation rates for total copper and total zinc, respectively, for the SSN 688 vessel class. A full listing of vessel classes and characteristics for calculating generation rates and mass loadings are included in Appendix C.

Table 3-1. SSN 688 Vessel Class Estimated Generation Rates for Total Copper

Class	Number of Vessels	Days In Port	Days in Transit (0-12 nm)	Days Underway (12+ nm)	Daily generation rate per vessel (kg Cu/day)			Annual generation rate per class (kg Cu/year)		
					In Port	Underway (0-12 nm)	Underway (12+ nm)	In Port	Underway (0-12 nm)	Underway (12+ nm)
SSN 688	51	183	2	180	3.1×10^{-1}	6.0×10^{-1}	6.0×10^{-1}	2.9×10^{3}	61	5.5×10^{3}

Note: This analysis does not account for a submarine's time in drydock.

Table 3-2. SSN 688 Vessel Class Estimated Generation Rates for Total Zinc

Class	Number of Vessels	Days In Port	Days in Transit (0-12 nm)	Days Underway (12+ nm)	Daily generation rate per vessel (kg Zn/day)			Annual generation rate per class (kg Zn/year)		
					In Port	Underway (0-12 nm)	Underway (12+ nm)	In Port	Underway (0-12 nm)	Underway (12+ nm)
SSN 688	51	183	2	180	1.3×10^{-1}	2.4×10^{-1}	2.4×10^{-1}	1.2×10^{3}	24	2.2×10^{3}

Note: This analysis does not account for a submarine's time in drydock.

3.1.2 Uncertainty Information

The uncertainty information for this vessel class and the baseline is the same as for Steel, Composite, and Non-Aluminum Rigid Hulls vessel group except that vinyl antifouling coatings are not used. The discussion of the uncertainty information is contained in Section 2.1.2.

3.2 ESTABLISH A MAXIMUM ALLOWABLE COPPER RELEASE RATE FOR ANTIFOULING COATINGS

This MPCD option group is similar to the baseline discharge. Additional characterization and calculations are not necessary. The same coatings discussed in the baseline discharge would be used to establish the release rate standard. As discussed previously, the numerical maximum allowable copper release rate standard would be based on the results of ongoing Navy testing using the American Society for Testing and Materials (ASTM) D 6442, *Standard Test Method for Copper Release Rates of Antifouling Coating Systems in Seawater* and these results are not expected, or intended, to correlate with actual, in-service leach rates.

3.3 FOUL-RELEASE COATINGS

As discussed in the *Hull Coating Leachate FIAR*, foul-release coatings were tested on an Australian submarine in the 1990s resulting in excessive hull fouling (DSTO, 1995; Holmdahl, 2000). Before foul-release coatings could be applied to U.S. Navy submarines, performance validation testing would be required on an existing Navy nuclear submarine to ensure that significant damage would not occur to critical shipboard systems. Validation testing has not been done. Therefore, the foul-release coatings MPCD option is not feasible for this vessel group, and no characterization was conducted.

3.4 ADVANCED ANTIFOULING COATINGS

The use of advanced antifouling coatings on flexible hulls is not approved by the current specifications for underwater hull antifouling coatings. In Navy testing, panels coated with *E Paint SN-1* did not meet the minimum performance requirements of military specification MIL-PRF-24647 and as such is not authorized for use on Navy vessels (Lawrence, 2003). As a result, this MPCD option is not feasible for the Flexible Hulls vessel group and no characterization was conducted.